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## TTY Report for April 2002

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## 1. Purpose

This document outlines the progress made by VoiceStream toward the FCC mandate, contained in 47 CFR Section 20.18, that operators of digital wireless systems must be capable of transmitting 911 calls from individuals with speech or hearing disabilities through the use of Text Telephone Devices (TTY). The rule requires compliance with this mandate on or before June 30, 2002. The capabilities that VoiceStream is developing here will also support the FCC's policy of full user-to-user functionality employing TTY devices. This document, which is for information purposes, is submitted to the TTY Forum of the Alliance for Telecommunications Industry Solutions (ATIS).

## 2. Executive Summary

VoiceStream uniformly employs the GSM air interface. Standardization work for a GSM TTY solution is continuing and VoiceStream is active in facilitating testing and decisions that will enable 911 access as well as full user-to-user functionality. VoiceStream will deploy different solutions, depending on vendor and equipment type. VoiceStream uses network equipment from Ericsson, Nokia and Nortel in different geographical areas of the US.

VoiceStream was instrumental in working with the global GSM community to get agreement on a common signaling mechanism applicable to both the Network Switching Subsystem (NSS) and Base Station System (BSS) solutions. Having obtained global community agreement on using bearer capability signaling, VoiceStream has been working diligently with its network equipment vendors to test and verify the performance of both the NSS and BSS implementations.

During December 2001, VoiceStream loaded into its laboratories in Snoqualmie, Washington, test loads for Nortel and Ericsson TTY implementations. Test loads for Nokia were delayed due to Nokia's difficulties with the E911 Phase 2 portion of its Base Station Controller (BSC) software. On January 31, 2002, Nokia released its first TTY test load. Of the three network infrastructures employed, only that of Ericsson has passed final testing. Nortel delivered the first load for the newest BSC configuration in December 2001, but testing has been delayed due to technical problems with the new 3G BSC. Nortel's load for the 2G BSC is currently under test. VoiceStream notes that Nokia completed TTY testing in the laboratory April 10, 2002, and is preparing to load the software for field tests.

Based on the current information from our vendors, VoiceStream expects to have final solutions from all vendors for testing by the end of April 2002. Testing and verification of these commercial loads will take two to four weeks. VoiceStream has already started TTY deployment in Ericsson markets and envisages being in the position to start deployment in Nokia and Nortel markets at approximately the end of April 2002, with full implementation by the June 30, 2002 date.

To date, VoiceStream has issued purchase orders of approximately \$5.5 million to cover the necessary hardware and software upgrades and initial deployment costs.

### 3. Background

Since September 1997, the Wireless TTY Forum (TTY Forum), representing wireless carriers, wireless equipment manufacturers, manufacturers of TTY devices, public safety organizations, and consumer organizations representing individuals who are deaf or hard-of-hearing has been meeting in an effort to develop solutions that will enable TTY users to make 911 calls on digital wireless networks. Technical solutions had been proposed for all major wireless standards and these solutions have been undergoing study in the relevant technical bodies, TR45.5 (CDMA), TR45.3 (TDMA) and T1P1/3GPP (GSM).

The GSM solution uses the Cellular Text Telephony Modem (CTM) as a method of transmitting Baudot over the GSM network. It is difficult to transmit Baudot code over the digital channel of GSM at the FCC-mandated standard of a 1 percent Total Character Error Rate (TCER), as the digital codecs have been optimized for speech. Baudot uses frequency components at 1.4 and 1.8 kHz, which would be attenuated by the low pass filtering in the codecs. In addition, the error correcting protocols of GSM result in the character error rate for a Baudot Code transmission increasing dramatically in the case of decreasing channel quality.

For this reason, CTM had been designed to work with all speech coding strategies and it has been successfully tested with the relevant codecs for the US, which are the GSM FR, EFR and all modes of the AMR codec. CTM signals have components only between 400 Hz and 1000 Hz, which corresponds to the natural range of human speech. A converter would handle the CTM functionality at the mobile, which would be either incorporated into the mobile or available as a clip-on/add-on unit.

The three documents specifying CTM have now been approved in the U.S. as American National Standards. These documents have also been submitted to 3GPP and have become the basis for the specifications developed by that group for all GSM systems worldwide.

TTY support in GSM networks has been formalized and is outlined in Technical Specifications-TS 23.002 and TS 23.226. TTY support is enabled using one of three solutions:

- The "all transcoder solution (All-TRAU)" with CTM on every circuit leading out to the terminals.
- The "CTM circuit pool solution" with a mechanism for selecting a circuit leading to the terminal that has the proper CTM detection/conversion capabilities, based on the terminal indicating that it has CTM capabilities.
- The "CTM-SRF [specialized resources function] service node solution" with a service node in the core network and a mechanism to route through it for CTM detection/conversion.

The GSM technical specifications require the support of Bearer Capability Signaling from the handset to the network for both the circuit pooling as well as service node solutions. This solution for a common signaling mechanism allows a handset to signal the network at call setup that it is sending a CTM call and thus the network can direct that call to a network path that can convert the CTM signal into Baudot.

Because the signaling mechanism is common to both the server as well as the circuit pooling solutions and is transparent to the All-TRAU solution, the wireless system operator can choose the equipment option that best fits its equipment implementation yet still maintain interoperability across platforms. The signaling mechanism is totally transparent to the user – that is, a TTY call can be made by any CTM-capable handset regardless of the network implementation utilized by the wireless system operator.

## 4. VoiceStream's Network Progress

VoiceStream has issued Purchase Orders totaling approximately \$5.5 million to cover the initial deployment of TTY. Additional funds have been budgeted to cover any additional costs associated with the testing and deployment phases. VoiceStream has firm technical and commercial proposals from all three network equipment vendors.

Each vendor has chosen a slightly different implementation option based on its analysis of the ease and speed of the particular deployment solution.

<b>Nokia</b>	Implementing the All-TRAU solution which requires a software upgrade to all transcoder units. The software to support CTM/TTY is part of the company's S.10 release.
<b>Nortel</b>	Supporting the All-TRAU solution on the BSC E3 platform using the TCU E3 transcoder. CTM/TTY is supported in release 13.2. For the BSC 2G, Nortel is supporting the CTM circuit pooled solution requiring release 12.4D+.
<b>Ericsson</b>	Implementing the Service Node solution, using Telegent (Sweden) servers. The new servers are supported by the R9 BSC and MSC software releases.

Irrespective of the implementation option chosen by the vendor, the process for testing the CTM/TTY functionality will proceed as outlined below.

**Laboratory Functional Testing (LFT)** - Testing of the CTM functionality as a stand-alone function will be performed in a controlled environment. Software employed may be pre-release. The aim of this testing is to confirm that the CTM translation is correct and that the CTM/TTY functionality is able to meet the defined GSM and FCC requirements. The testing of (early) pre-release software code may not involve full call control functionality but may only test the CTM/TTY translation performance.

**Laboratory Acceptance Tests (LAT)** - Testing of the full end-to-end functionality of the new software and hardware needed to support TTY, including regression tests of basic GSM features such as voice call completion, GPRS call completion etc, to ensure that software changes have not introduced unforeseen errors in other blocks of code.

**Soak Test (ST)** - A stability period to ensure that software and hardware is stable and is able to operate in a normal loaded condition.

**First Office Application (FOA)** - Limited deployment in the live network, to ensure that no unforeseen problems occur that could not be observed in the laboratory.

**General Acceptance (GA)** - Full deployment to all relevant network nodes.

The table below shows the current progress and latest estimated start dates for each of the phases of the test and verification program. The program shows the testing dates and the expected start of national deployment (GA).

**Table 1: Estimated Test and Verification Dates**

	<b>LFT</b>	<b>LAT</b>	<b>ST</b>	<b>FOA</b>	<b>GA</b>
<b>Nokia</b>	01/24/02	02/18/02	04/22/02	04/15/02	06/18/02
<b>Nortel 2G BSC</b>	04/01/02	04/11/02	04/18/02	05/01/02	06/21/02
<b>Ericsson</b>	01/26/02	02/15/02	02/25/02	03/27/02	05/15/02

Nokia and Ericsson have now completed LAT testing (Nokia as of April 10<sup>th</sup>). Nortel is still to complete lab testing.

Ericsson started deployment of its TTY solution in VoiceStream's Washington, DC market area on March 27, 2002. As of the date of this report, deployment of the R9 software release for the MSCs has been accomplished for Boston and Philadelphia as well. Field-testing of the solution is now progressing. Installation in all VoiceStream markets is scheduled to be completed by mid-May 2002.

Testing of Nokia's TTY solution is planned for Kansas City for April 15, 2002, when the S.10 release is loaded.

As is the case when introducing new functions and features into the network, there is some element of risk in the program being delayed due to unforeseen technical difficulties.

## **5. VoiceStream's Handset Availability**

TTY-capable handsets have been selected and approved by VoiceStream. The Ericsson T61 will be available in May. Motorola models P280i and V60i will be available in June. The Nokia DCT-4 and higher model handsets will all be TTY-capable.

Interoperability between handsets and infrastructure will not be an issue.

## 6. Conclusion

VoiceStream anticipates meeting the June 30, 2002 mandate for provision of wireless TTY access to 911 emergency services. VoiceStream notes, however, that serious concerns remain concerning the ability of Public Safety Answering Points (PSAPs) to process wireless 911 TTY calls. As documented by the ATIS-sponsored TTY Technical Standards Implementation (TTSI) Incubator, in a February 4, 2002 letter to FCC Wireless Telecom Bureau Chief Thomas Sugrue, problems occurred when a TTY call is terminated at certain PSAPs, whereby the total character error rate (TCER) significantly exceeds the permitted 1 percent. In a subsequent ex parte meeting with the Commission on March 12, 2002, details concerning this problem were discussed. While the magnitude of the problem identified with some PSAP equipment vendors remains uncertain, as a member of the TTSI, VoiceStream will continue its work towards the June 30, 2002 mandate.